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Defense Energy Support Center

**Product
Technology
&
Standardization
Division**

Alternative Fuels Information Station

Synthetic Fuels Tutorial





Learning Objectives



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You should learn....

- Important definitions around synthetic fuels
- Why synthetic fuels are needed
- Some detail on the promising methods of producing synthetic fuels
- U.S. demand for petroleum products
- Basic properties of synthetic fuel products





DEFINITIONS



SYNTHETIC FUEL DEFINITIONS



WHAT IS SYNTHETIC FEEDSTOCK?

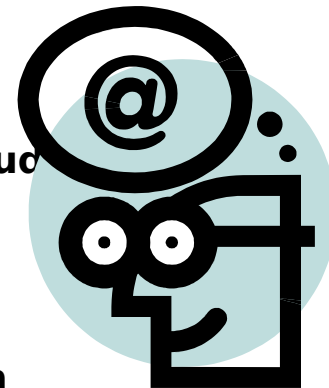


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Definitions of Synthetic Fuel

Synthetic Feedstock

Any feedstock **NOT** produced from conventional petroleum crude



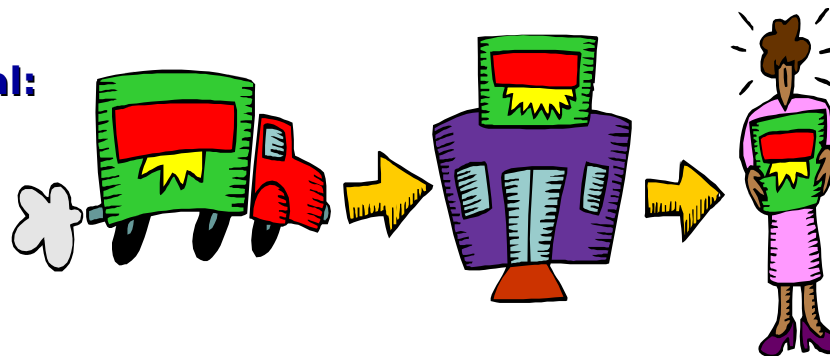
Synthetic Fuels

A generic name given to hydrocarbon fuels produced from natural gas, coal, or biomass.



Resource can be any burnable material:

Coal
Biomass
Natural gas





Why are Synthetic Fuels Needed?



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5 Reasons for continued production and improvement of synthetic fuels

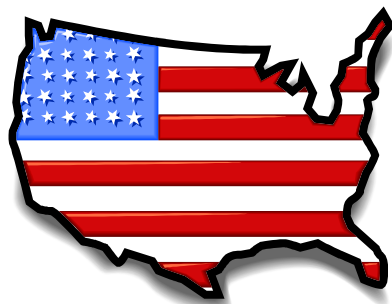
World has a finite supply of conventional crude oil

U.S. demand for crude oil is steadily increasing

The world jet fuel market is decreasing

National Security and energy independence

Synthetic Fuels help reduce U.S. dependency on foreign oil



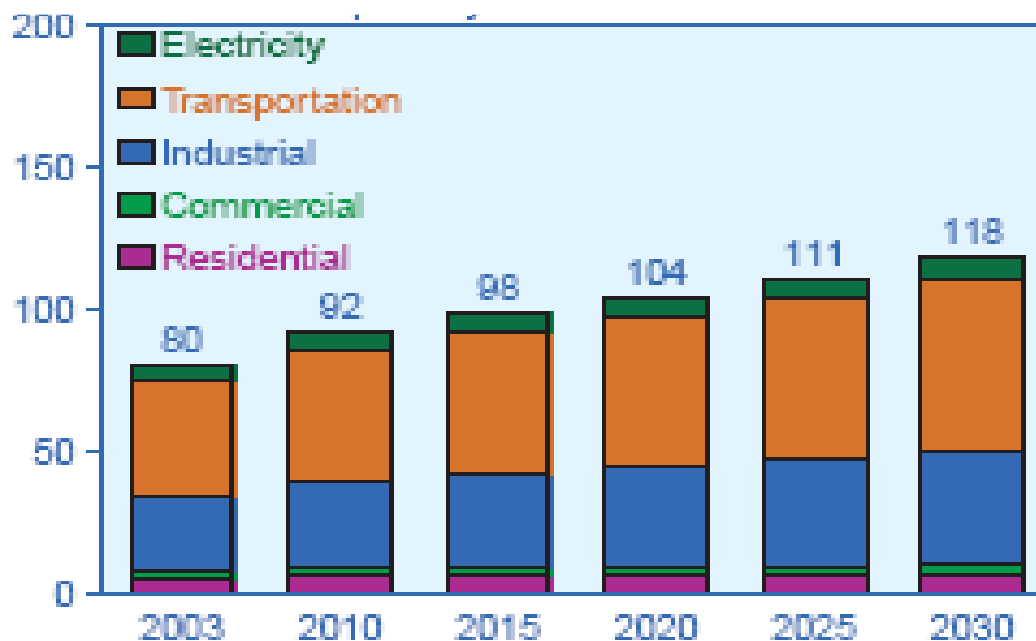


Crude Oil Consumption



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By Sector:





Department of Defense Synthetic Fuel Initiative



- **DoD's long term requirement is for 110,000 bbl/day (40 Mbbl/yr) of "neat" to enable a 50/50 blend**
- **Ultimate goal is an assured domestic source of synfuel to replace half of D domestic jet and Navy distillate consumption in an environmentally compli**
- **Synfuel is a replacement for jet fuel (JP-8, JP-5, Jet A, Jet A1), Navy petrole distillate (NPD, F-76), and diesel (DF)**





Synthetic Feedstock Processes



Synthetic Feedstock sources include:

1. Natural Gas to Liquids



2. Coal Gasification: Producing synthetic natural gas from Coal



3. Coal Liquefaction: Conversion of coal to liquid for use as a synthetic fuel

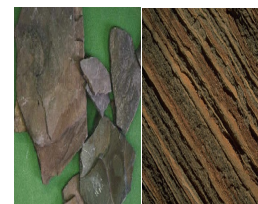


Alternate Sources of Petroleum Crudes



Alternate crude sources include:

1. **Shale Oil:** Extracted hydrocarbon known as Kerogen from shale (large shale formations Exist in Colorado, Utah, and Wyoming)



2. **Tar Sands:** Extraction of very heavy, asphalt “like” crude oil called Bitumen from grains of sand, or, in some cases, porous carbonate rocks. The U.S. has some tar sands mainly in Utah. The largest deposits are in Canada.





Refining Synthetic Crudes



Fisher-Tropsch Process

Fisher-Tropsch (FT) is an emerging technology for Converting synthetic crude to synthetic fuels.

Brief History

- **Developed by Germany during World War II to make gasoline from coal.**
- **Developed out of necessity from a lack of available crude oil.**
- **Modernized in South Africa by SASOL Corporation.**



What is FT?

Converts coal, natural gas, and low-value refinery products into high value, clean burning fuel!

FT offers important emissions benefits compared to conventional fuel.

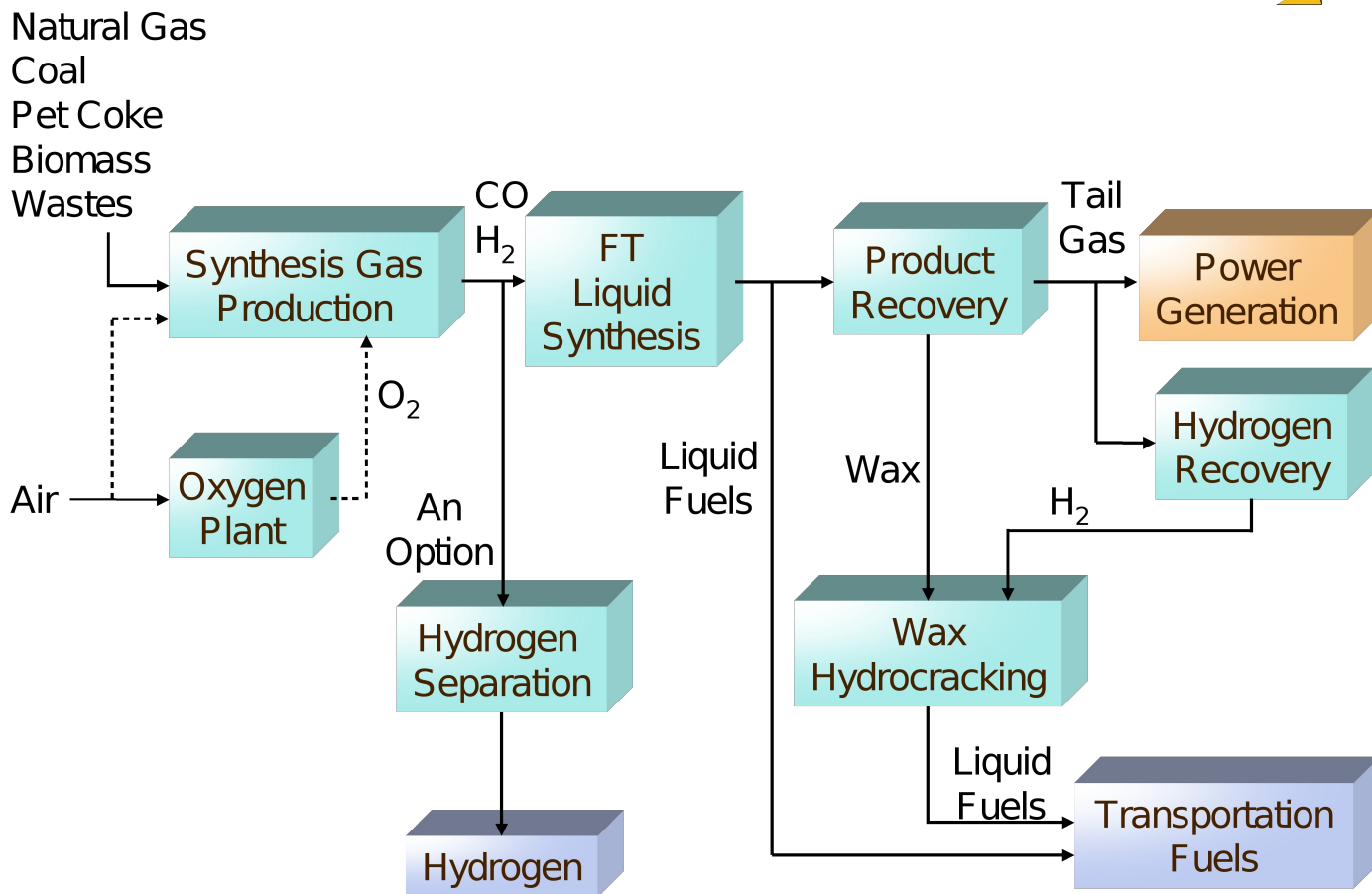




Fisher Tropsch Technology



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Petroleum Crude Oil Processing-Conventional and Synthetic



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Input

Crude Oil/Synthetic Feedstock

Primary Separation

Distillation

Distillation

Naptha Cut

C₃ & C₄ Olefins

Distillate Cuts

Conversion

Coking

Cracking

Impurity Removal

Hydrogenation

Hydrogenation

Hydrogenation

Upgrading

Distillation

Distillation

Distillation

Products

Gasoline

Kerosene/Jet Fuels

Diesels/Fuel Oils





Major Producers of Fisher-Tropsch Fuels



South Africa's Sasol is the largest producer

Other projects include:

BP (Nikiski, AK)

Conoco-Phillips (Ponca City, OK)

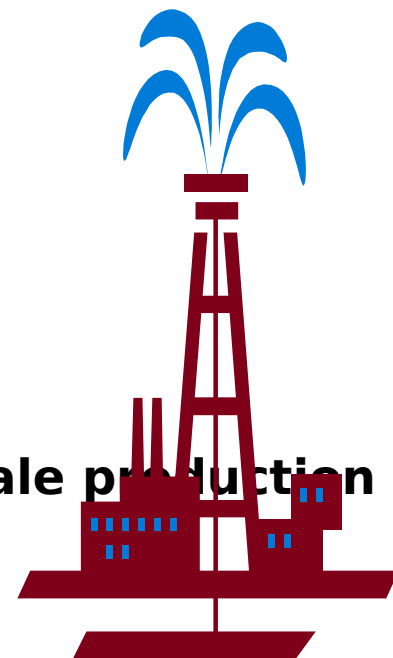
Syntroleum (Tulsa, OK)

Shell Maylasia

Exxon Mobile Qatar

Chevron

There are other oil companies developing large scale production Operations using Fisher-Tropsch technology!





SYNTHETIC FUEL



SYNTHETIC FUEL FROM BIOMASS



Synthetic Fuels from Biomass Processing



Synthetic fuels can be created from **"Biomass"**

Biomass can be any plant derived organic matter, available on a renewable basis including:

- Dedicated energy crops and trees
- Agricultural food and feed crops
- Agricultural crop wastes
- Wood wastes and residues
- Aquatic Plants
- Animal wastes
- Municipal wastes and other waste materials





Biomass Resources in the United States



- Abundant, natural and renewable resource
- Supplements fossil energy supply
- Helps create energy security and independence
- Can be used to produce fuels, power, and many chemicals



Source: www.eere.energy.gov/biomass



Biomass Usage



- Leading source of renewable energy in U.S. since 1999
- Provides fuel, heat, electricity, chemicals and other products
- Agricultural and forestry residues most common resource for generating electricity and process steam
- Increases use of crops for biodiesel and ethanol



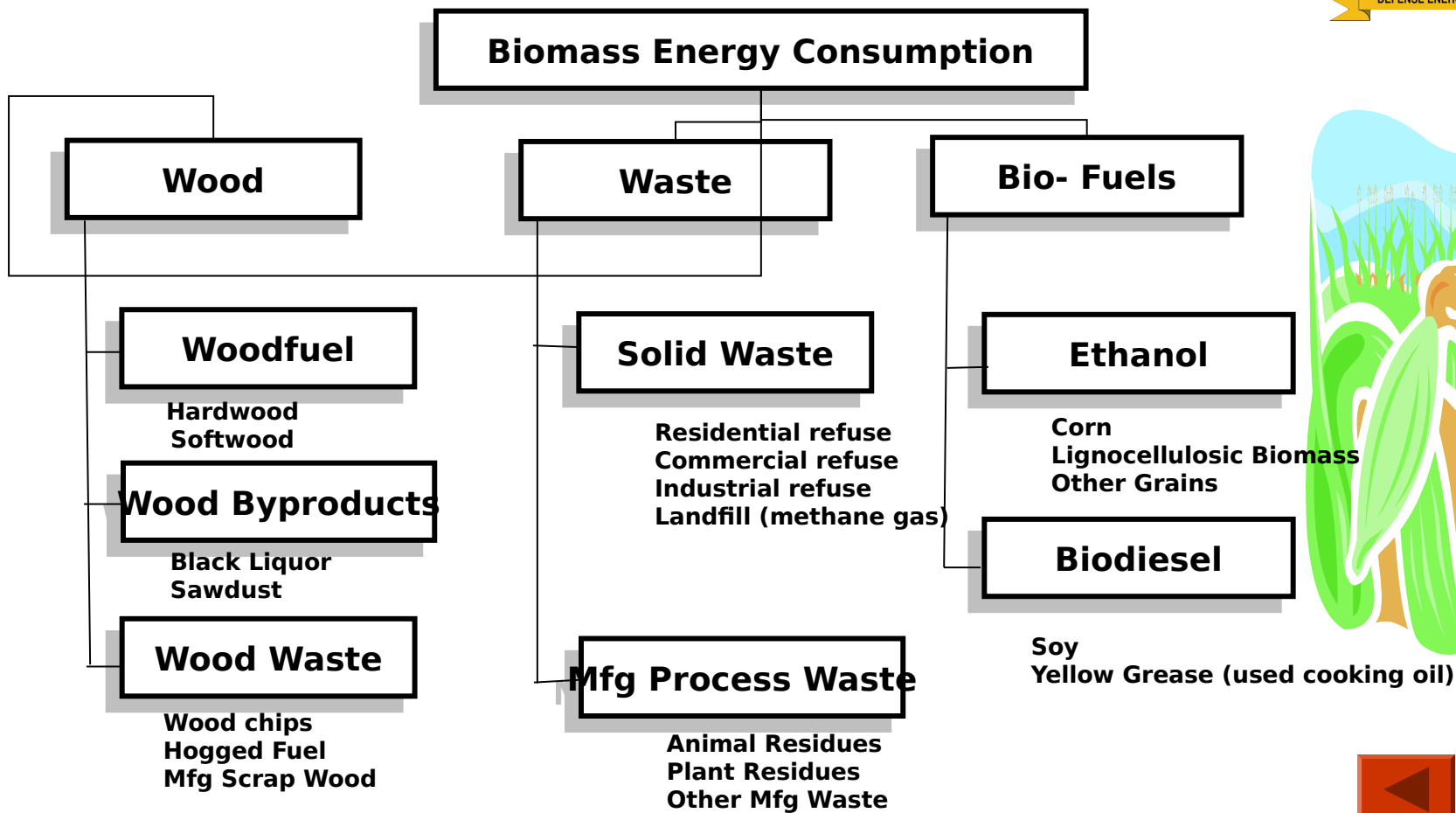
Source: www.eere.energy.gov/biomass



Biomass Resource Hierarchy



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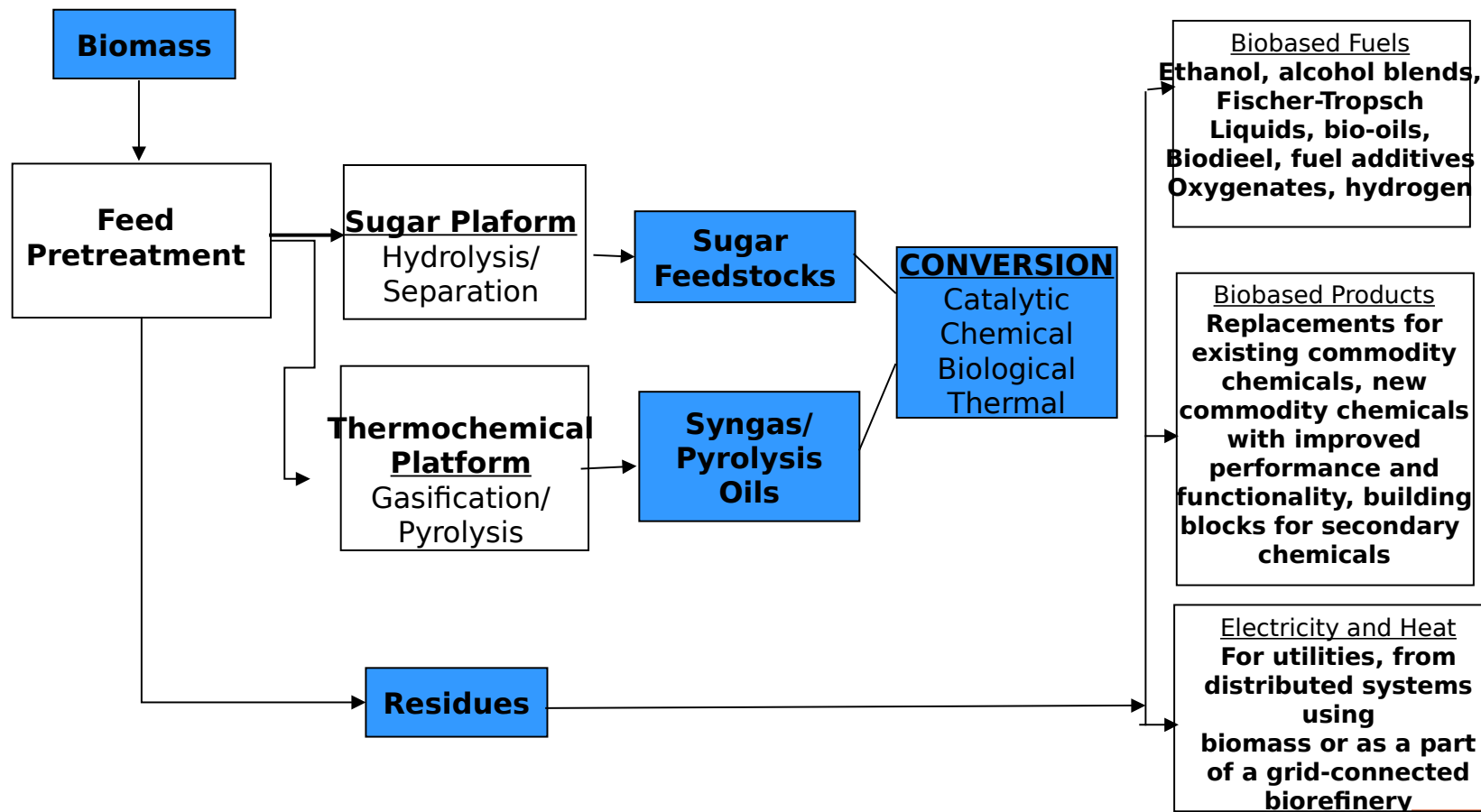


Biomass Platforms



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Biomass Platforms for producing fuels





Synthetic Fuels in the Transportation Sector



SYNTHETIC FUELS IN THE TRANSPORTATION SECTOR



WHAT ARE TRANSPORTATION FUELS?



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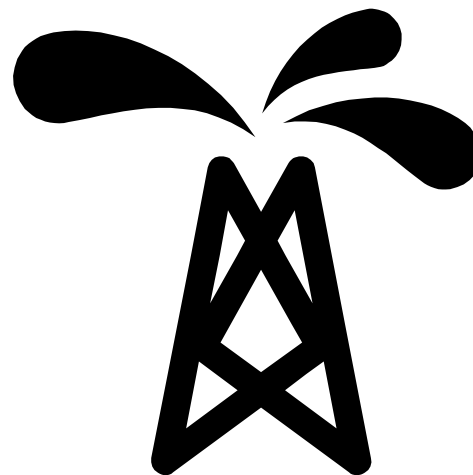
Transportation Fuels



Transportation fuels are refined from conventional petroleum (hydro-carbon based) crude oils.

They include:

- Jet Fuels
- Diesel Fuels
- Gasolines
- Marine Fuels

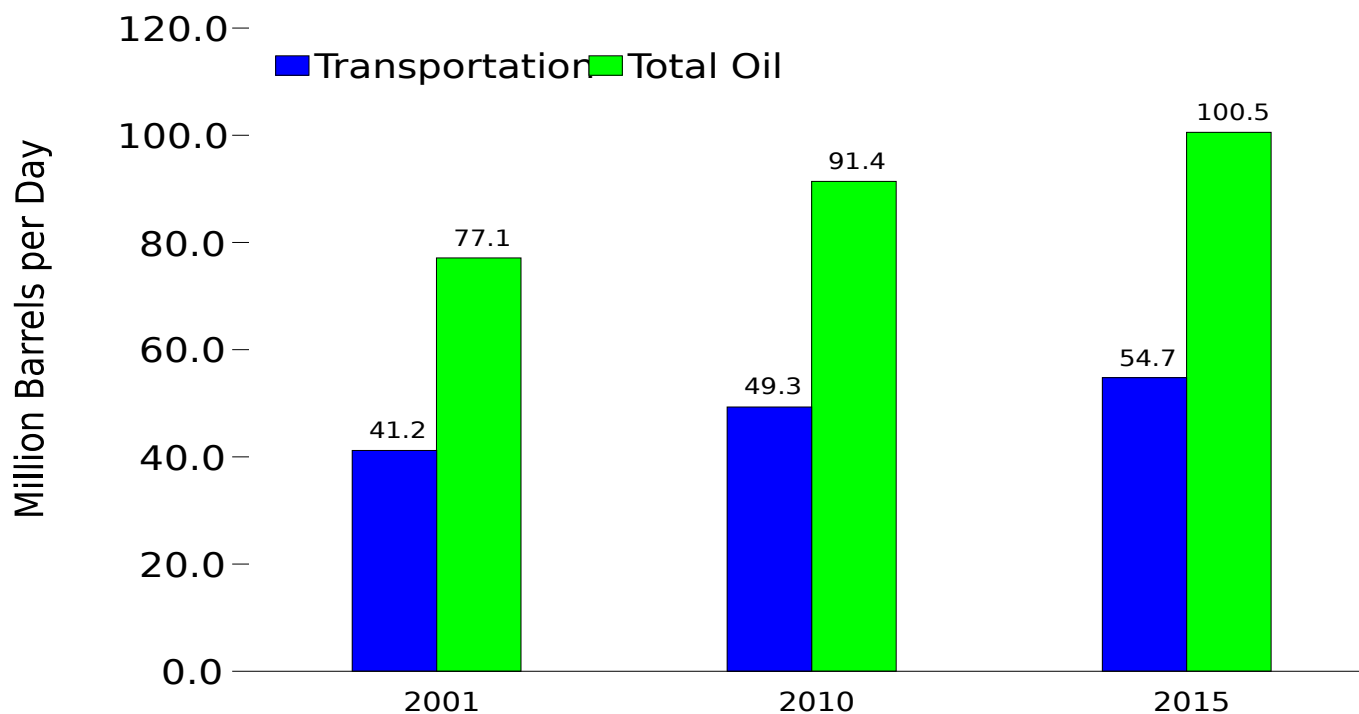




TRANSPORTATION FUEL USAGE



Transportation Fuel Usage vs. Total Fuel Oil Consumption



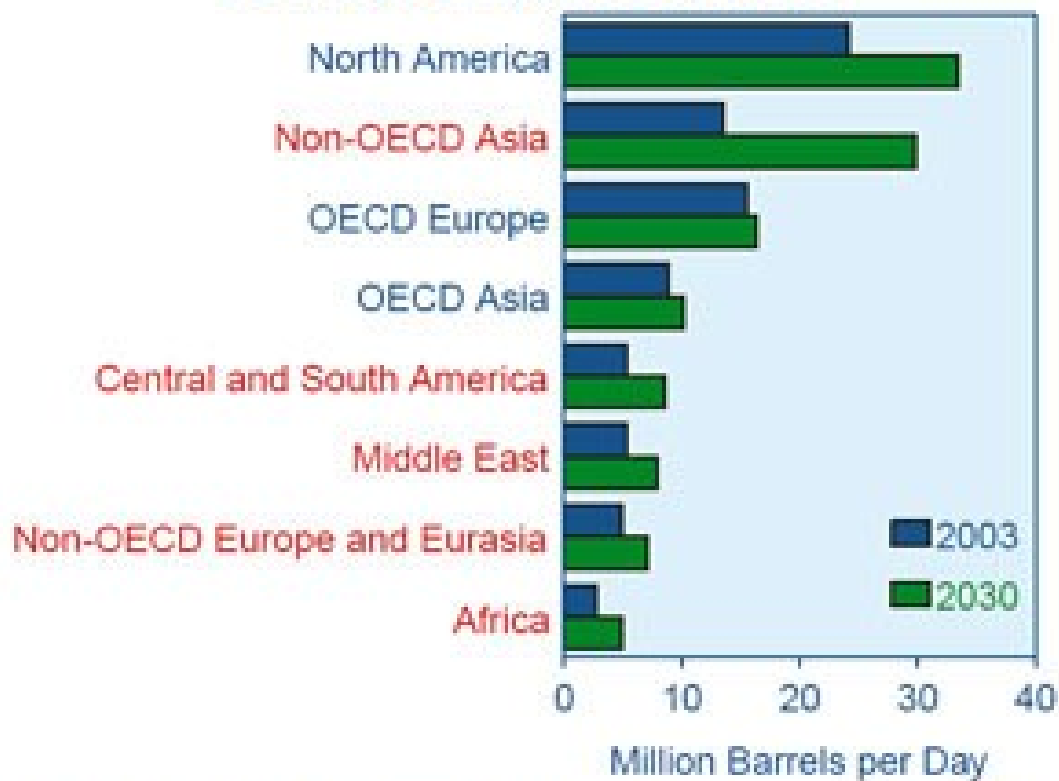


Oil Consumption by Region



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World Oil Consumption by Region and Country Group, 2003 and 2030



OECD- Organization for Economic Cooperation and Development

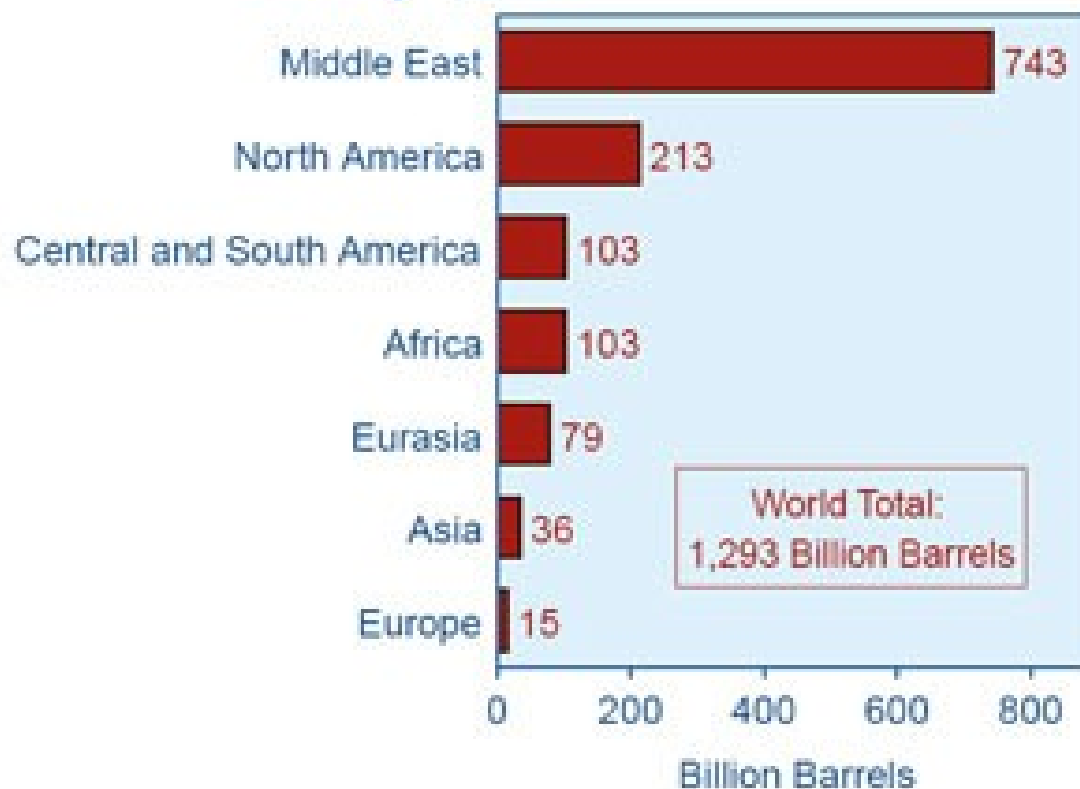




World Oil Reserves



World Proved Oil Reserves
by Geographic Region as of
January 1, 2006





Selected Country Production and Consumption



Projected Demand

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(Million Barrels per Day, Except OECD Commercial Stocks)

	2006				2007				2008				Year		
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	2006	2007	2008
Demand *															
OECD															
U.S. (50 States).....	20.4	20.5	20.8	20.7	20.9	20.7	21.0	21.1	21.1	21.0	21.3	21.3	20.6	20.9	21.2
U.S. Territories	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Canada	2.2	2.1	2.3	2.3	2.2	2.2	2.2	2.3	2.2	2.2	2.2	2.3	2.2	2.2	2.2
Europe	15.8	15.0	15.4	15.8	15.5	15.1	15.6	15.8	15.5	15.1	15.5	15.8	15.5	15.5	15.5
Japan	6.0	4.8	4.8	5.4	5.8	4.7	4.9	5.5	5.8	4.7	4.9	5.4	5.2	5.2	5.2
Other OECD	5.4	5.1	5.1	5.4	5.5	5.2	5.1	5.5	5.5	5.2	5.2	5.6	5.3	5.3	5.4
Total OECD	50.1	48.0	48.8	50.0	50.4	48.3	49.3	50.6	50.7	48.6	49.6	50.8	49.2	49.6	49.9

Projected Supply

U.S. (50 States).....	8.2	8.4	8.5	8.5	8.5	8.4	8.5	8.7	8.9	8.9	8.9	9.1	8.4	8.5	8.9
Canada	3.3	3.2	3.3	3.4	3.5	3.4	3.4	3.5	3.5	3.5	3.6	3.6	3.3	3.4	3.6
Mexico	3.8	3.8	3.7	3.5	3.6	3.6	3.6	3.6	3.4	3.4	3.4	3.3	3.7	3.6	3.4
North Sea *	5.1	4.7	4.5	4.8	4.8	4.6	4.4	4.7	4.6	4.4	4.1	4.3	4.8	4.6	4.3
Other OECD	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total OECD	21.8	21.4	21.5	21.7	21.8	21.5	21.4	21.8	21.9	21.7	21.5	21.8	21.6	21.6	21.7



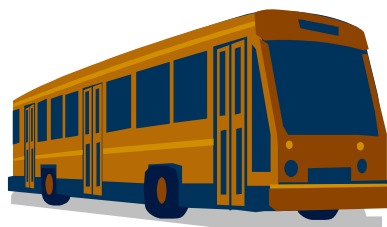


Synthetic Fuel as a Transportation Fuel



Synthetic fuel can typically be:

- ✓ **Used with the existing distribution infrastructure**
- ✓ **Used in conventional vehicles (diesel/gasoline/kerosene-jet fuel)**





Transportation Fuel Specifications



TRANSPORTATION FUEL SPECIFICATIONS



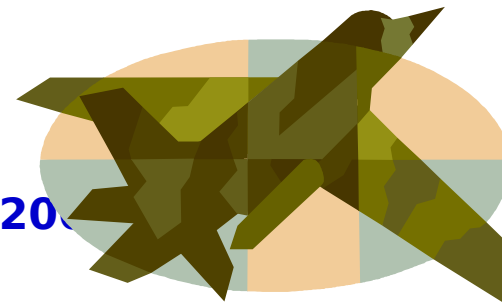
Specification Provisions



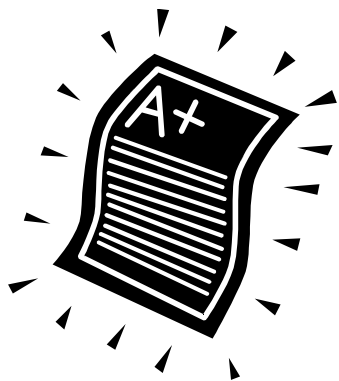
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Synthetic Aviation Fuels:

Required to meet Standard Specification for Aviation Fuels- ASTM-D-1655 and Defense Standard 91/91/Issue 5, 8 February 20



Only SASOL Corporation's semi-synthetic fuel blend of conventional kerosene and synthetic kerosene meets this requirement thus far!



Defense Standard 91/91-Issue 5, stipulates, “ the use of blends represents a departure from experience.....” therefore, “an interim solution ...to approve fuels containing synthetics componen on an individual basis” is actively performed.



Specification Provisions

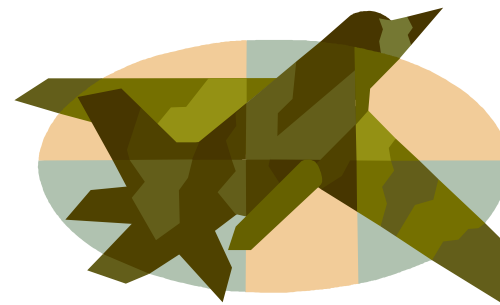


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Synthetic Aviation Fuels (Con't):

JP-8 MIL-DTL-83133E, April 1999

JP-5 MIL-DTL-5624U, 5 January 2004



Allows for various crudes:

“crude oil derived from petroleum, tar sands, oil shale or mixtures thereof..”

Section 3.1 Materials, MIL-DTL-5624U, 5 January 2004



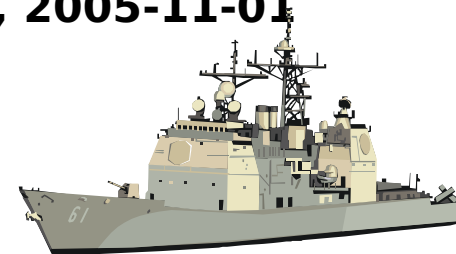
Specification Provisions (con't)



Marine Fuel:

ISO 8217: Specifications of Marine Fuels, 3rd Edition, 2005-11-01

Allows oils from Tar Sands and Shale



Synthetic Diesel Fuels:

ASTM-D-975

Hydrocarbon source not specified for diesel fuels





Key Advantages of Synthetic Fuels



- ✓ **Can use existing infrastructure**
- ✓ **No sulfur (exceeds EPA 2006 regulations)**
- ✓ **Lower engine exhaust emissions**
- ✓ **Less toxic- no aromatics, bio-degradable, no hetero-atoms**
- ✓ **Abundant domestic feedstocks**
- ✓ **Excellent low temperature properties**
- ✓ **Strong long term storage stability**





Present Limitations of Synthetic Fuels



X Low lubricity for Diesel, Jet, and Marine Fuels

X Material compatibility issues in Jet Fuels (e.g. zero aromatics and the effects on seals)

All issues are solvable:

- Additives can be used to remedy lubricity concern.
- Material compatibility can be remedied by the use of blends initial
- Further development can force progress to full synthetic.





Summary



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You should now understand....

- Important definitions around synthetic fuels
- Why synthetic fuels are needed
- Understanding of synthetic fuel processes
- U.S. demand for petroleum products
- Basic properties of synthetic fuel products





FAQs



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1. What are Synthetic Fuels and why are they needed?
2. What are the different types of Synthetic Fuels?
3. How are Synthetic Fuels made?
4. What is the Fisher -Tropsch Process?
5. Which companies are in the business of producing synthetic fuel?
6. What is Biomass and how is it used to as a source of energy?
7. Which transportation fuel specifications allow synthetic fuels.
8. What are some of the advantages of Synthetic fuels.
9. What are the disadvantages of Synthetic fuels?

